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## Review

# Is synaesthesia a predisposing factor to post-traumatic stress disorder?

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## 1. Abstract

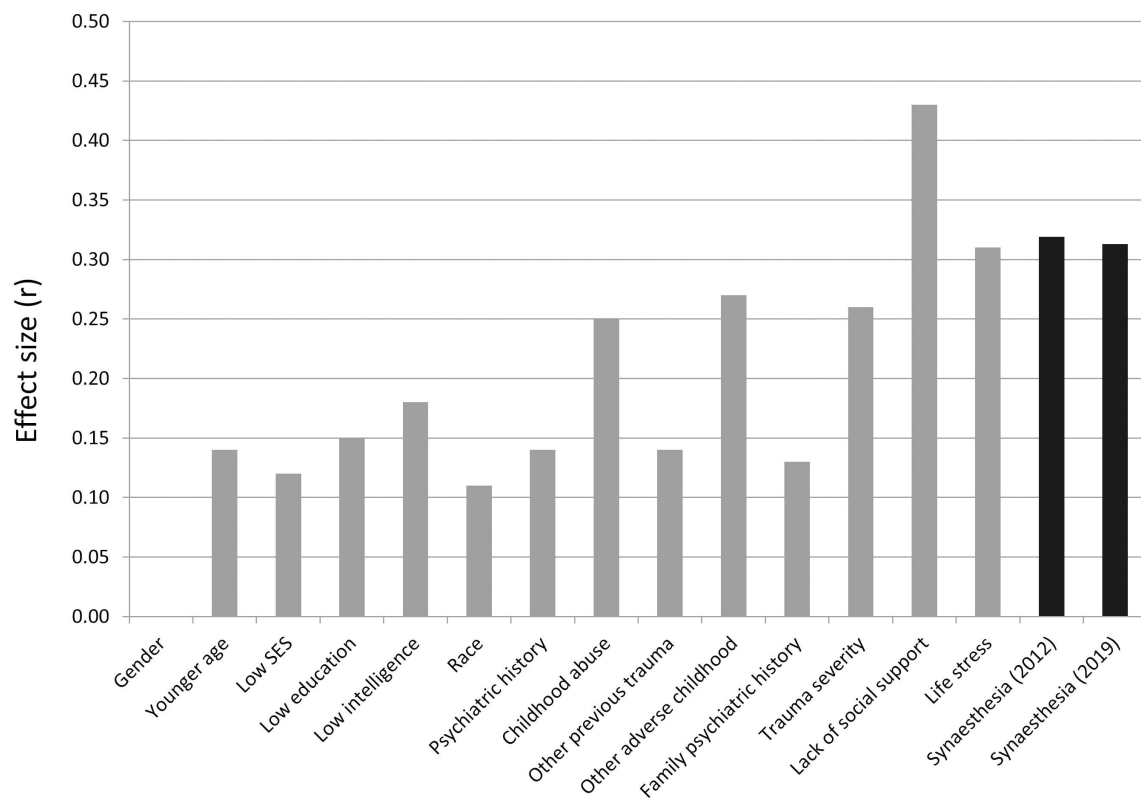
This article summarises recent evidence that suggests that synaesthesia is one of the largest known risk factors for the development of the post-traumatic stress disorder (PTSD). This important and novel finding is explained in terms of the underlying cognitive differences that are found in people with synaesthesia. When asked to recall previous (non-traumatic), events, synaesthetes are more likely to report re-experiencing sensory and affective details from the time of the event and are more likely to report reliving the event from a first-person perspective. These memory qualities, perhaps coupled with memory inflexibility, may act as a clinical vulnerability to flashbacks following exposure to trauma.

## 2. Is there evidence for a link?

Two studies to date have suggested a link between synaesthesia and PTSD in military veterans exposed to trauma [1, 2]. The 2012 study had a sample size of  $N = 700$ , and the 2019 replication study had a sample size of  $N = 1730$ . These studies reported that the odds-ratio of having PTSD given a report of grapheme-colour synaesthesia (GCS) was 3.4 and 3.3 respectively (Odds ratio is measure of degree of association where 1.0 reflects no association). The effects remain significant after adjusting for factors such as depression and degree of combat exposure, which were not linked to synaesthesia. The authors used conventional diagnostic criteria for PTSD, which included the presence of a recent flashback. We note that the largest

group of veterans had served during the Vietnam War, over four decades earlier, suggesting a high degree of robustness of the symptom. If these effect sizes are compared to other known risk factors [3] then the presence of synaesthesia would be one of the largest known risk factors for PTSD. This is shown in Fig. 1.

However, there is reason to be cautious about these results because the researchers did not verify GCS using the standard objective measures of synaesthesia (test-retest consistency of grapheme-colour associations). Instead, they used a self-report measure in an interview. How should we interpret the findings in light of this? Firstly, self-report is implicitly used by all researchers in the field such that a verified synaesthete would not only have to pass a consistency test but he/she would have to declare (in some way) that they have this kind of experience. Someone who denied having this kind of experience would conventionally be classed as a non-synaesthete irrespective of any objective test performance. The upshot of this is that the 'non-synaesthete' groups in Hoffmann *et al.* [1, 2] would also have been classed as non-synaesthetes even if a conventional procedure had been used, but the 'synaesthete' group would contain a mixture of genuine synaesthetes (i.e. who would have passed a consistency test) and non-synaesthetes (who would not). The reported prevalence of GCS by Hoffmann *et al.* [1, 2] were 3.4% and 6% respectively. These are higher, but not hugely so, compared to studies using consistency measures: 2.5% in Carmichael *et al.* [4], 1.4% in Simner and Carmichael [5], and around 4% if one also considers coloured days and months [6]. If we assume that the genuine synaesthetes are driving the association, then the



**Fig. 1. Risk factors associated with PTSD in military veterans.** Gray bars are reproduced from the meta-analysis of Brewin *et al.* [3] using weighted average  $r$ . The black bars show data from the two published studies on synaesthesia and PTSD [1, 2]. Note: odd-ratios reported in these papers were translated to  $r$  effect sizes using the formulae according to Borenstein *et al.* [7].

addition of some non-synaesthetes into that group would have the effect of underestimating the true degree of association between PTSD and synaesthesia. Conversely, it is theoretically possible that the association is being driven solely by the non-synaesthetes who mistakenly claim to have synaesthesia. This account appears far less plausible, particularly in light of other evidence that suggests a parallel between synaesthetic memories (from conventionally-verified synaesthetes) and PTSD flashbacks. This is considered below.

### 3. How does the cognitive profile of synaesthesia predispose towards PTSD?

People with synaesthesia have a particular set of cognitive abilities [8] or ‘cognitive style’ [9]. It may be these differences, rather than the presence of synaesthesia itself, that leads to an association between synaesthesia and PTSD. In particular, synaesthetes have a particular tendency to think using vivid mental images across multiple senses [10], which, of course is likely intimately related to the synaesthesia. Synaesthetes also show differences in memory processing in both laboratory tests [11] and on measures such as the Autobiographical Memory Questionnaire [12]. Using the latter, Chin and Ward [12] found

that synaesthetes report that their real-world memories are richer in sensory detail (e.g., “As I remember the event, I can hear it in my mind.”), more affect-laden (“I can feel the emotions that I felt then”), and tend to be relived in the present (“As I remember the event, I feel that I travel back in time when it happened as if participating in it again. I feel as if I am reliving it.”). These memory ratings were elicited by recall of everyday rather than traumatic events, but the phenomenological parallels with flashbacks in PTSD are obvious. Moreover, synaesthetes showed less fading of these characteristics over time when asked to recall events from childhood. Finally, synaesthetes are more likely to report remembering events (recent and remote) through an “own eyes” first-person perspective, also called a field perspective [12]. In non-synaesthetes, own-eyes perspectives are linked to the recall of emotionally salient events more than neutral ones [13], and when people with PTSD are asked to adopt an own-eyes perspective to recall trauma, it leads to more recall of affective and somatic details [14]. In effect, what appears to be a sign of enhanced memory in synaesthetes may, in the context of trauma, turn into a liability.

Differences in memory functioning have been proposed to be a cognitive risk factor (or intermediate phenotype) for the development of PTSD. For instance, one theory specifically proposes that contextual updating of

memories is a vulnerability mechanism in the development of PTSD, which effectively acts against a rewriting of the traumatic memory [15]. A fear-conditioning paradigm with a subsequent contextually-modulated extinction phase has been shown to distinguish people with PTSD from a trauma-exposed control group [16]. One testable prediction is that synaesthetes will show the same pattern as PTSD patients even in the absence of PTSD. A recent study, using a different method, found that people with synaesthesia show less contextual updating of memories by perseverating towards previous contexts [17]. As such, it is conceivable that the memory of synaesthetes may be inflexible despite, on many measures, being objectively good [11]. In effect, rewriting one's own history may require memories that are either weak or flexible (or both). Synaesthetes have neither.

In summary, although there is evidence that links synaesthesia to PTSD, there is need for further evidence with standard measures for verifying synaesthesia. I speculate that this reflects cognitive differences linked to imagery and memory that acts as a clinical vulnerability to flashbacks following exposure to trauma.

#### 4. Author contributions

JW is sole author responsible for writing the manuscript.

#### 5. Ethics approval and consent to participate

Not applicable.

#### 6. Acknowledgment

Not applicable.

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#### 8. Conflict of interest

The author declares no conflict of interest.

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**Abbreviations:** GCS, grapheme-colour synaesthesia; PTSD, Post-traumatic stress disorder.

**Keywords:** Post-traumatic stress syndrome; PTSD; Synaesthesia; Synesthesia; Memory; Mental imagery; Trauma; Review

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